PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference 205787/KCS/GJS/DG	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)

International application No. PCT/EP 02/00277	International filing date *(day/month/year)* 09.01.2002	Priority date *(day/month/year)* 09.01.2002

International Patent Classification (IPC) or both national classification and IPC
H04B7/08

Applicant
NOKIA CORPORATION et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   I   ☒   Basis of the opinion
   II   ☐   Priority
   III ☐   Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   IV   ☐   Lack of unity of invention
   V   ☒   Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   VI   ☐   Certain documents cited
   VII ☐   Certain defects in the international application
   VIII ☐   Certain observations on the international application

Date of submission of the demand	Date of completion of this report
31.07.2003	13.05.2004

Name and mailing address of the International preliminary examining authority:	Authorized Officer
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.   PCT/EP 02/00277

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

   Description, Pages

   1-17   as originally filed

   Claims, Numbers

   1-37   received on 08.01.2004 with letter of 07.01.2004

   Drawings, Figures

   1-4, 6   as originally filed
   5*   filed with the demand

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐   the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐   the language of publication of the international application (under Rule 48.3(b)).

   ☐   the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐   contained in the international application in written form.

   ☐   filed together with the international application in computer readable form.

   ☐   furnished subsequently to this Authority in written form.

   ☐   furnished subsequently to this Authority in computer readable form.

   ☐   The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.   ·

   ☐   The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐   the description,   pages:

   ☐   the claims,   Nos.:

   ☐   the drawings,   sheets:

5. ☐   This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-37
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-37
Industrial applicability (IA)	Yes:	Claims	1-37
	No:	Claims	

2. Citations and explanations

   see separate sheet

Section V

Reference is made to the following document:

D1: WO 00 52845 A1 (THE BOARD OF TRUSTREES, LELAND STANFORD
JUNIOR UNIVERSITY) 8 September 2000

Claim 1

D1 discloses iterative multi-user detection using cross correlation of two signals.
According to D1 (see e.g. the Abstract) the method includes receiving a composite
signal including different signals, whereby an estimation of the primary data and an
estimation of the superimposed cross talk signal is iteratively computed. D1 (see fig. 7
and page 22 line 12 to page 23, line 6 in particular page 22, lines 22 - 24) specifies that
the expected values computed by the first decoder are arranged to be input into the
second decoder and the expected values computed by the second decoder are
arranged to be input into the first decoder.

Further D1 (see e.g. page 22, lines 17 - 20 and lines 24 to 29; see also claims 12 and
13) teaches that the first decoder is arranged to compute a probability distribution P1
for each of the possible values for the first signal (the primary data signal X_1) and the
second decoder is arranged to compute a probability distribution P1 for each of the
possible values for the second signal (the superimposed cross talk signal X_2). It is
considered that "a plurality probable values" derived from a probability distribution is
equivalent to "a plurality of potential values". Thus it is considered that D1 discloses
that the processing means is arranged, for each already determined estimate to extend
the estimate with a plurality of potential values. Therefore the extended estimate value
of a first signal may change in dependence on the extended estimate of the second
signal.

The subject matter of claim 1 differs only in that the receiver has a plurality of receiving
elements. However the subject matter focuses on the processing of the signals for a
single receiving element and not on the interaction between the different receiving
elements, thus the feature "a plurality of receiving elements" does not involve an
inventive step.

Thus the subject matter of claim 1 is formally new but does not involve an inventive
step.

Therefore claim 1 does not satisfy the requirements of Article 33(3) PCT.

Dependent claims 2 - 19

Claim 2

D1 foresees also an initial estimation being either the pseudo-inverse or e.g. zero (see D1, page 11, lines 3 to 10).

Claims 3 and 4

In the present application as well as in D1, the composite received signal is considered as a linear combination of signals. Thus there is no fundamental difference having a linear combination of two or three or more signals. The skilled person will extend the proceeding of two signals to three or more signals, without any inventive step.

Claims 5 and 6

Ranking the signals dependent on the SNR is a standard procedure in the field of transmission.

Claims 7 to 18

These claims disclose different estimates which are equivalent, or how to stop the iteration or the use of matrix equations which belong to the common knowledge of a skilled person (see also the present description, e.g. page 10, 1 and 2).

Claim 19

It is obvious for the skilled person that the receiving elements in receiver systems comprise antennas.

Thus dependent claims 2 to 19 do not contain any features which, in combination with the features of claim 1, meet the requirements of the PCT in respect of inventive step.

Claims 20 to 37

Method claims 20 to 37 correspond to device claims 1 to 18. Since the statements regarding the latter apply also to the method claims 20 to 37, the subject matter of claims 20 to 37 do not involve an inventive step as required by Article 33(3) PCT.

CLAIMS

1.   A receiver for receiving a plurality of signals at the same time, said receiver comprising:

        a plurality of receiving elements each of which is arranged to receive a composite signal including at least some of said plurality of signals;

        processing means for receiving said plurality of receiving elements composite signal and providing an estimate of at least two of said plurality of signals, said processing means being arranged to provide an estimate of a first one of said signals and then to provide an estimate of a second one of said signals wherein said processing means is arranged, for each already determined estimate to extend the estimate with a plurality of potential values, wherein said estimate of said second one of said signals takes into account the estimate of the first signal and the estimate of the first signal can be modified in dependence on the estimate of the second signal.

2.   A receiver as claimed in claim 1, wherein said processing means is arranged to provide an initial estimate of said plurality of signals, said processing means using said initial estimate as a first value for said first and second estimates.

3.   A receiver as claimed in claim 1, wherein said processing means is arranged to provide an estimate of at least three signals and the estimate of each successive signal takes into account the previously determined signal estimates.

4.   A receiver as claimed in claim 1 or 3, wherein said processing means is arranged to provide an estimate of at least three signals and any one or more of the previously determined estimated can be modified in dependence on a current signal estimate.

5.   A receiver as claimed in any preceding claim, wherein said processing means is arranged to determine the order in which the signals are estimated.

6.   A receiver as claimed in claim 5, wherein said processing means are arranged to determine the order in which the signals are estimated taking into account at least one of received signal level and signal to noise ratio.

7. A receiver as claimed in claim 1, wherein said potential values comprise constellation points.

5 8. A receiver as claimed in claim 7, wherein said estimate is extended by every possible constellation point.

9. A receiver as claimed in any of claims 1 to 8, wherein said plurality of potential values comprise potential values for a currently estimated signal.

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10. A receiver as claimed in any of claims 1 to 9, wherein a metric is determined for the extended estimates.

11. A receiver as claimed in claim 10, wherein at least some of said extended
15 estimates are discarded in dependence on the determined metric.

12. A receiver as claimed in claim 10 or 11, wherein one or more existing estimates are discarded if a determined metric is better than that of said one or more existing estimates.

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13. A receiver as claimed in any of claims 10 to 12, wherein said metric is based on a function of the currently determined estimates and the received signal

14. A receiver as claimed in claim 13, wherein said function is a squared Euclidean
25 distance between said currently determined estimates and the received signal.

15. A receiver as claimed in any of the claims 10 to 13 wherein said metric is calculated for a signal estimate at least partially from metric values stored during the calculation of a previously determined estimate.

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16. A receiver as claimed in any preceding claim, wherein said processor is arranged to treat those signals for which an estimate has not yet been determined as noise.

17.   A receiver as claimed in any preceding claim, wherein the processor is arranged, before determining any estimates to calculate at least one of:

 the matrix product of the channel transfer function multiplied by itself;

 the squared length of the channel impulse response for at least one signal received by at least one receiving element; and

 an inner function defined by the received signal multiplied by the channel impulse response.

18.   A receiver as claimed in any preceding claim, wherein for each estimate, the quantities

$||r-H(v_s+v_e)||^2$, $||r-Hv_s||^2$, $2\Re\{(c_k- _k)^*(e_k^H H^H Hv_s - h_k^H r)\}$, $|c_k- _k|^2 ||h_k||^2$

are calculated.

19.   A receiver as claimed in any preceding claim, wherein said receiving elements comprise antennas.

20.   A method for receiving a plurality of signals at the same time, said method comprising the steps:

 receiving at each of a plurality of receiving elements a composite signal including at least some of said plurality of signals;

 processing said received plurality of receiving elements' composite signal to provide a estimate of at least two of said plurality of signals;

 said processing step being arranged to provide an estimate of a first one of said signals and then to provide an estimate of a second one of said signals wherein during said processing step, for each already determined estimate, the estimate is extended with a plurality of potential values,

 wherein said estimate of said second one of said signals takes into account the estimate of the first signal and the estimate of the first signal can be modified in dependence on the estimate of the second signal.

21.   A method as claimed in claim 20, wherein said processing step further provides an initial estimate of said plurality of signals, said processing step using said initial estimate as a first value for said first and second estimates.

22.   A method as claimed in claim 20, wherein said processing step further provides an estimate of at least three signals and the estimate of each successive signal takes into account the previously determined signal estimates.

23.   A method as claimed in claim 20 or 22, wherein said processing step provides an estimate of at least three signals and any one or more of the previously determined estimated can be modified in dependence on a current signal estimate.

24.   A method as claimed in claims 20 to 23, wherein said processing step further determines the order in which the signals are estimated.

25.   A method as claimed in claim 24, wherein said processing step further determines the order in which the signals are estimated taking into account at least one of received signal level and signal to noise ratio.

26.   A method as claimed in claim 20, wherein said potential values comprise constellation points.

27.   A method as claimed in claim 26, wherein said estimate is extended by every possible constellation point.

28.   A method as claimed in any of claims 20 to 27, wherein said plurality of potential values comprise potential values for a currently estimated signal.

29.   A method as claimed in any of claims 20 to 28, wherein a metric is determined for the extended estimates.

30.   A method as claimed in claim 29, wherein at least some of said extended estimates are discarded in dependence on the determined metric.

31.   A method as claimed in claim 29 or 30, wherein one or more existing estimates are discarded if a determined metric is better than that of said one or more existing estimates.

5   32.   A method as claimed in any of claims 29 to 31, wherein said metric is based on a function of the currently determined estimates and the received signal

33.   A method as claimed in claim 32, wherein said function is a squared Euclidean distance between said currently determined estimates and the received signal.

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34.   A method as claimed in any of the claims 29 to 32 wherein said metric is calculated for a signal estimate at least partially from metric values stored during the calculation of a previously determined estimate.

15   35.   A method as claimed in claims 20 to 34, wherein the step of processing treats those signals for which an estimate has not yet been determined as noise.

36.   A method as claimed in claims 20 to 35, wherein the step of processing further comprises the steps, prior to the step of determining any estimates, of calculating at
20   least one of:
        the matrix product of the channel transfer function multiplied by itself;
        the squared length of the channel impulse response for at least one signal received by at least one receiving element; and
        an inner function defined by the received signal multiplied by the channel impulse
25   response.

37.   A method as claimed in claims 20 to 35, wherein for each estimate, the quantities $\|r-H(v_s+v_e)\|^2$, $\|r-Hv_s\|^2$, $2\Re\{(c_k-_k)^*(e_k^H H^H Hv_s-h_k^H r)\}$, $|c_k-_k|^2\|h_k\|^2$ are calculated.